THURSDAY, OCTOBER 7, 1875

THE ASTRONOMY OF THE BABYLONIANS

THE astronomical science of the ancient Babylonians and their pupils, the Assyrians, was neither so profound nor so contemptible as has often been maintained. Now that we are able to read the native records written in the cuneiform or wedge-shaped character, we find that the progress made at a very early period in mapping out the sky, in compiling a calendar, and above all in observing the phenomena of the heavens, was really wonderful, considering the scanty means they possessed of effecting it. Certainly their astronomy was mixed up with all kinds of astrological absurdities, but this did not prevent them from being persistent and keen observers, whose energy in the cause of knowledge is not undeserving of imitation even in the present day.

The originators of astronomy in Chaldea, as indeed of all other science, art, and culture there, were not the Semitic Babylonians, but a people who are now generally termed Accadians, and who spoke an agglutinative language. They had come from the mountains of Elam or Susiana, on the east, bringing with them the rudiments of writing and civilisation. They found a cognate race already settled in Chaldea, and in conjunction with the latter they built the great cities of Babylonia, whose ruins still attest their power and antiquity. Somewhere between 3000 and 4000 B.C. the Semites entered the country from the east, and gradually contrived to conquer the whole of it. It is probable the conquest was completed about 2000 B.C. At all events, Accadian became a dead language two or three centuries later, but as the Semitic invaders owed almost all the civilisation they possessed to their more polished predecessors, it remained the language of literature, like Latin in the Middle Ages, down to the last days of the Assyrian Empire.

Astronomy was included in the branches of science borrowed by the Semitic Babylonians from the Accadians. Consequently their astronomical records contain many words which belong to the old language, while most of the stars bear Accadian and not Semitic names. Even where the Assyro-Babylonians had a technical term of their own, like *kasritu*, "conjunction," they continued to *write* the old Accadian word *ribanna*, of which *kasritu* was a translation, though they probably *pronounced* it *kasritu*, just as we pronounce *viz.* "namely."

The oldest Chaldean astronomical records of which we know are contained in a great work called "The Observations of Bel," in 70 books, compiled for a certain King Sargon of Agané, in Babylonia, before 1700 B.C., and of which we possess later copies or editions, made for the Library of Sardanapalus at Nineveh. The catalogue of this work shows that a great part of it was purely astrological; other books, however, were more scientific. Thus there was one on the conjunction of the sun and moon, another on comets, or, as they are called, "stars with a corona in front and a tail behind," a third on the movements of Mars, a fourth on the movements of Venus, and a fifth on the Pole-star.* The catalogue concludes with a curious intimation to the student, who is told to write down the number of the tablet or book he wishes to consult, and the librarian will thereupon hand it to him. The larger portion of the work itself has been recovered, though some of the tablets belonging to it still lie under the soil of Kouyunjik, and a good part of the details which follow is extracted from this primitive Babylonian treatise.

* That is, α Draconis.

The Accadians seem to have begun their astronomical observations before they left Elam, since the meridian was placed in that country, while the old mythology made "the mountain of the East" the pivot on which the sky rested. This will account for the large number of eclipses recorded in the "Observations of Bel," which imply a corresponding antiquity for the commencement of such records. These records were carefully kept, as there were State Observatories in most of the Babylonian and Assyrian towns—at Ur, Agané, Nineveh, and Arbela, for instance—and (at all events in later times) the astronomers royal had to send fortnightly reports to the King.

It is to the Accadians that we owe both the signs of the Zodiac and the days of the week. The heaven was divided into four parts, and the passage of the sun through these marked the four seasons of the year. A tablet brought home by Mr. Smith informs us that the spring quarter lasted from the 1st of the month Adar to the 30th of the month Iyyar (that is, from the 1st degree of Pisces to the 30th degree of Taurus), the summer quarter from the 1st of Sivan to the 30th of Ab (the 1st degree of Gemini to the 30th of Leo), the autumn quarter from the 1st of Ebul to the 30th of Marchesvan (the 1st degree of Virgo to the 30th of Scorpio), and the winter quarter from the 1st of Chisleu to the 30th of Sebat (the 1st degree of Sagittarius to the 30th of Aquarius). The fact that the spring quarter did not commence with the beginning of the year in Nisan or March, shows that the scheme was subsequent to the formation of the calendar.

The year was divided into twelve lunar months and 360 days, an intercalary month being added whenever a certain star, called "the star of stars," or *Icu*,* which was just in advance of the sun when it crossed the vernal equinox, was not parallel with the moon until the 3rd of Nisan, that is, two days after the equinox. This, however, did not always suffice to keep the seasons in order, and the calendar had more than once to be rectified by the intercalation of other so-called months, consisting of a few days each. Cycles of twelve solar years were also in use, during which the same weather was expected to recur. The day was divided into twelve *casbumi*, or "double hours," each of these being further subdivided into sixty minutes and sixty seconds. The month, too, was cut into two halves of fifteen days, each subdivided into periods of five days, though a week of seven days was also employed from the earliest times. The days of the week were named after the sun, moon, and five planets; and since the 7th, 14th, 19th, 21st, and 28th of the month were termed "days of rest" on which certain works were forbidden to be done, it is clear that the origin of our modern week must be referred to the ancient Chaldeans. The names of the months were taken from the corresponding signs of the Zodiac, and as the Zodiac

* Called *Dil-gan*, or "messenger of light," in Accadian. It must be identified with τ Arietis, and at a later time with α Arietis.

began with Aries and the year with Nisan, neither the Zodiac nor the Calendar of the Accadians could be earlier than 2540 B.C. This is also indicated by the fact that even as late as the composition of the "Observations of Bel," time is calculated in the case of eclipses, not by the *casbu*, or "double hour"—a word which is Accadian, and not Semitic—but by the older division into three watches. These consisted of four hours each, beginning at 6 P.M. and ending at 6 A.M., and they were called respectively the "evening," "middle," and "morning" watches. Something like an accurate measurement of time was attained by the invention of the clepsydra.

Eclipses of the moon were observed from a very early epoch; but numerous as are the records of them in the great astronomical work of Sargon's Library, the vague and unscientific way in which they are recorded renders them of little value. The usual formula is: "In the month so and so, on the 14th day, an eclipse takes place, beginning on the east and ending on the west: it begins in the middle watch [10 P.M. to 2 A.M.], and ends in the morning watch, the shadow being eastward from the commencement to the cessation of the eclipse." In subsequent times, however, the language of the observatory reports becomes more precise and the gradual progress of an eclipse is carefully described. Long before the reign of Sargon of Agané, the discovery had been made that lunar eclipses recur after a cycle of 223 lunations, and records of them incorporated into the "Observations of Bel" generally begin with the words "According to calculation," or (it may be) "Contrary to calculation, the moon was eclipsed." One of the most curious tablets now in the British Museum is one of lunar longitudes, which seems to have formed part of the great Babylonian work on Astronomy, but, since it is written in Accadian, must be older than 2000 B.C. As a translation of it has not been made before, it is here given in full:—

1.	The 1st day (the moon) advances	5 deg.
2.	The 2nd day ,, ,, ...	10 deg.
3.	The 3rd day ,, ,, ...	20 deg.
4.	The 4th day ,, ,, ...	40 deg.
5.	The 5th day ,, ,, ...	80 deg.
6.	The 6th day ,, ,, ...	96 deg.
7.	The 7th day ,, ,, ...	112 deg.
8.	The 8th day ,, ,, ...	128 deg.
9.	The 9th day ,, ,, ...	144 deg.
10.	The 10th day ,, ,, ...	160 deg.
11.	The 11th day ,, ,, ...	176 deg.
12.	The 12th day ,, ,, ...	192 deg.
13.	The 13th day ,, ,, ...	208 deg.
14.	The 14th day ,, ,, ...	224 deg.
15.	The 15th day ,, ,, ...	240 deg.
16.	The 16th day for 224 deg. of advance it retrogrades*	16 deg.
17.	The 17th day for 208 deg. ,, ,,	32 deg.
18.	The 18th day for 192 deg. ,, ,,	48 deg.
19.	The 19th day for 176 deg. ,, ,,	64 deg.
20.	The 20th day for 160 deg. ,, ,,	80 deg.
21.	The 21st day for 144 deg. ,, ,,	96 deg.
22.	The 22nd day for 128 deg. ,, ,,	112 deg.
23.	The 23rd day for 112 deg. ,, ,,	128 deg.
24.	The 24th day for 96 deg. ,, ,,	144 deg.
25.	The 25th day for 80 deg. ,, ,,	30 deg.
26.	The 26th day for 32 deg. ,, ,,	56 deg.
27.	The 27th day for 23 deg. ,, ,,	12 deg.
28.	The 28th day for 15 deg. ,, ,,	26 deg.
29.	The 29th day for $5\frac{1}{20}$ deg. ,, ,,	$4\frac{2}{3}$ deg.
30.	The 30th day the moon is the god Anu.	

The fractions at the end of the tablet are hard to explain, and it is unfortunate that the month is not named during which the observations were made, and that we have no other tablet of a similar kind to compare with it. It will be noticed that here, as everywhere else in Babylonian mathematics, the soss or 60 was the unit, and also that the path of the moon was divided into 240 (60 × 4) degrees. This corresponds with an analogous division of the equator into 240°, η Piscium being 60°, γ Piscium (or rather α Pegasi) 80°, and so on. An inner circle was drawn within the equatorial and divided into 120 (60 × 2) degrees, a line passing through η Piscium being 30°, and 10° being marked for every 20° of the equator. The ecliptic, "the yoke of the sky" as it was picturesquely called, was divided into 360°, 30° for each sign.* It is curious that no trace is to be found of the 28 *nakshatras* or lunar mansions of Hindu and Chinese astronomy which have been so confidently assigned to a Babylonian origin. Should M. Biot, however, be right in holding that there were primarily but 24 of these, the four additional ones being added by the Chinese sage, Cheu-kung (B.C. 1100), it is possible that they might be connected with the 24 zodiacal stars which, according to Diodorus, were called "judges" by the Babylonians, 12 being north and 12 south.

The problem of calculating solar eclipses by tracing the shadow as projected on a sphere had also presented itself at an early period. Like eclipses of the moon, eclipses of the sun are spoken of as occurring either "according to calculation" or "contrary to calculation." In a report sent in to one of the later kings of Assyria by the State Astronomer, Abil-Istar states that a watch had been kept on the 28th, 29th, and 30th of Sivan, or May, for an eclipse of the sun, which did not, however, take place after all. The shadow, it is clear, must have fallen outside the field of observation. Besides the more ordinary kind of solar eclipses, mention is made of annular eclipses, which, strangely enough, are never alluded to by classical writers. It is interesting to find that observations were made as early as the time of Sargon of Agané on the varying colour of the sun, especially at the beginning of the year on the 1st of Nisan. Thus in one place we are told that the sun on that day was "bright yellow," in another place that it was "discoloured" (or rather "spotted").

Of the planets, only Mercury, Venus, Mars, Jupiter, and Saturn were known, besides the earth. These, however, excited great attention, and their phenomena were carefully studied. The movements of Venus and Mars especially attracted notice. Among the names given to Mars was that of "the vanishing star," in allusion to its recession from the earth, just as Jupiter was frequently called "the planet of the ecliptic," from its neighbourhood to the latter. The title of Mars just alluded to, however, raises the very interesting question whether the Babylonians had observed the phases as well as the movements of Venus and Mars. Now a report, taken from the "Observations of Bel," distinctly states that Venus "rises, and in its orbit duly grows in size," and this, in combination with the name of Mars as "the vanishing star," shows plainly that the phases of the two planets must have been noticed. Such a fact necessitates the existence of some kind of telescope,

* Literally, "becomes obscure."

* The Babylonian symbol for a degree was the star ✳.

however rude; and Mr. Layard's discovery of a crystal magnifying lens at Nineveh indicates that such an instrument may have actually been in use.*

The portion of Chaldean astronomy which was concerned with the planets was unnecessarily complicated by the habit of naming them from the fixed stars near which they happened to be at different times of the year, so that the same planet is often spoken of under varying names. Thus *Nibatanu* was properly Altair, but became a very common title of Mars. The number of the fixed stars observed by the Chaldeans was very great, and again suggests the use of something more than the naked eye. The principal stars had individual names, the rest being included in the constellations to which they belonged. In this way the heavens were mapped out long before the idea of a terrestrial atlas had suggested itself. The identification of the Chaldean constellations and fixed stars is of course a work of considerable difficulty, but the modern representatives of several of them have now been determined, and with the help of these and fresh astronomical texts, there is every reason to hope that our knowledge of the celestial globe of the Babylonians will be as complete as it is in the case of the Greeks and Romans.

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COMTE'S PHILOSOPHY

The Positive Philosophy of Auguste Comte, freely translated and condensed. By Harriet Martineau. In Two Volumes, 8vo. Second Edition. (London: Trübner and Co., 1875.)

THE first edition of Miss Martineau's version of the "Positive Philosophy" was published in the autumn of 1853. The considerable space of time which has since elapsed cannot have been due to any defect in the adapter's work. So excellently were the translation and condensation accomplished by Miss Martineau, that Comte substituted her two volumes for his own six volumes, and since Comte's death the work has actually been retranslated into French. It does not give us a great idea of the demand for Comte's works in England, when we find that twenty-two years intervene between the first and second editions. At last, however, the work is re-issued in two handsome volumes, but we are not informed that any alteration at all has been made either in the matter or language of the work, and I have not been able to detect a difference even in a word. The appearance of this new edition nevertheless affords an opportunity for a few remarks upon the value and pretensions of the "Positive Philosophy."

It has been asked "What's in a name?" As regards the positive philosophy, it may be answered that there is a great deal in the name. The name Positive is an admirable *question-begging epithet*. Everything which Comte wished to stamp with his approval, and make a part of his system, he called positive, and a formidable list of new names was invented. We have Positive Philosophy, Positivism, Positivity, Positive Method, Positive Polity, Positive Morality, and even Positive Practices. It would be much more correct to say Comte's Philosophy, Comtism, Comte's Method, Comte's Polity, Comte's Practices, because I believe it is impossible to attribute any invariable meaning to the word Positive, as used by Comte, except that it meant what belonged to his system. Nevertheless, the word was of inestimable value to Comte, because it enabled him to represent all his own views, some being of the most peculiar character, as the natural outcome of the Baconian Philosophy.

We frequently find Comte stating, in the frankest manner, that there was nothing new in the idea of a positive philosophy. Bacon and Descartes (vol. ii., pp. 381, 386, &c.) were the two great legislators of the philosophy. Even the common sense of ordinary thinkers contains all the elements of Positivism, provided that absurd metaphysical and theological ideas do not obscure them. Through Hume, Brown, and a few other philosophers, the pure method of positivism descended to Comte, whose mission it was to develop a complete system of positive thinking. When we attempt to find a clear definition of what the positive method is, it appears to be simply synonymous with the scientific method of induction, resting upon facts. Having thus invested himself with the prestige of whatever is best in the results of modern science, Comte proceeds to deliver at full length his own ideas of the origin and progress of civilisation, the grounds of morality, the best form of government, and the coming system of religious worship. All these ideas, being called positive, are of course the necessary outcome of the pure scientific method.

The following is one of the clearest statements, which I can find, of the nature of the positive method (vol. ii. p. 424):—"The Positive Philosophy is distinguished from the ancient . . . by nothing so much as its rejection of all inquiring into causes, first and final; and its confining research to the invariable relations which constitute natural laws. . . . We have accordingly sanctioned, in the one relation, the now popular maxim of Bacon, that observed facts are the only basis of sound speculation; so that we agree to what I wrote a quarter of a century ago,—that no proposition that is not finally reducible to the enunciation of a fact, particular or general, can offer any real and intelligible meaning. On the other hand, we have repudiated the practice of reducing science to an accumulation of desultory facts, asserting that science, as distinguished from learning, is essentially composed, not of facts, but of laws, so that no separate fact can be incorporated with science till it has been connected with some other, at least by the aid of some justifiable hypothesis." Now this passage not only contains very good sense, but it may be regarded as a most clear statement of what correct scientific method aims at, the ascertainment of general laws. But there is nothing whatever in this to distinguish the positive method from that pursued by all scientific inquirers who have any share of the spirit of Galileo, or Gilbert, or Newton, or Hooke, or Lavoisier, or Laplace, or Faraday. The question really is, then, whether Comte, having properly formulated the method of scientific inquiry, knew how to apply it in regions where he was not led by greater minds. There is no

* A broken tablet I have come across seems to record a transit of Venus across the sun. It is to be hoped that Mr. Smith will before long succeed in bringing to England the remainder of the Kouyunjik Library. At present a tablet is often broken off at its most interesting part, while the corresponding fragment is still lying under the soil on the banks of the Tigris.